'Rat vision' may give humans best sight of all

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Rat vision. Credit: alamodestuff

Humans have the best of all possible visual worlds because our full stereo vision combines with primitive visual pathways to quickly spot danger, a study led by the University of Sydney has discovered.

The surprising finding published today in *Current Biology* shows that in humans and other primates, information from the eyes is not only sent to the visual cortex for the complex processing that allows stereoscopic vision, but also could feed directly into deep brain circuits for attention and emotion.

"The brain cells that we identified suggest that human and other primates retain a visual pathway that traces back to the primitive systems of vertebrates like fish and frogs," said University of Sydney's Professor Paul Martin from the Sydney Medical School, who led the team that made the discovery.

"These connections may not have been lost during evolution of humans and other primates after all," says Martin, who speculates that primates have the best of all possible visual worlds: full stereo vision, and the ability to quickly spot and respond to danger.

The ability of the primate visual system to generate 3-D pictures of its surroundings is well recognised—that's what enables humans to play a game of tennis, and enjoy other fine motor skills such as threading a needle.

To do this, primates have two forward-facing eyes that capture the same view from slightly different angles, and a visual system that keeps information from each eye separate until it reaches the brain's visual cortex. There, complex processing combines the two views of the same scene to create 3-D vision.

Rodents, on the other hand, are more preoccupied with detecting and avoiding predators, and their visual systems reflect this: their eyes are on each side of their head, scanning different fields of view, and stereo vision is poor.

In both primates and rodents, messages from the two eyes enters the brain through a small structure called the lateral geniculate nucleus or LGN, which is made of slivers of nerve cells, arranged like sponge in a layer cake. And whereas in rodents LGN cells may fire in response to one or both eyes, until now, neuroscientists had thought that in primates, LGN cells fired only in response to inputs from a single eye.

Now, the Martin team has found a subset of cells, squeezed in between the main LGN layers in marmoset monkeys that fire in response to inputs from both eyes. The properties and connections of these 'two-eye' cells resemble cells in the rodent LGN.

"At first we thought we'd made a mistake, but we repeated the experiment, and we were right—the cells responded to inputs from either eye," says Natalie Zeater, a CIBF PhD Student and lead author on the paper.

What's more, in rodents the two-eye cells hook into sub-cortical areas of the brain such as the amygdala that help process emotion and fear responses, and areas that play a role in an animal's ability to spot salient events in its environment—an approaching cat for instance. How these primitive circuits work exactly is still mysterious. But they can be traced back in vertebrate brains from fish to frogs to rodents. The available evidence suggests that they trigger an alarm circuit that makes the brain more attentive to important visual cues—those to do with danger or food, for instance.

"There is no doubt that processing of complex visual information in the cerebral cortex is what enables uniquely human behaviours," says Martin. "But these two-eye cells suggest that other types of visual information are just as important—they allow the human species to survive to engage in the complex behaviours."

The researchers plan to delve deeper into the function of the two-eye cells, initially investigating whether there are the same direct connections between two-eye cells and emotion-processing centres as there are in rats.

More information: *Current Biology*, dx.doi.org/10.1016/j.cub.2015.10.033

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